

### Book Review

NACHTIGALL, WERNER. 1974. *Insects in Flight: A glimpse behind the scenes in biophysical research*. Translated by Oldroyd, R., R. H. Abbott and M. Biederman-Thorson. George Allen and Unwin, Ltd., London. 153 p. \$14.00

The title of this book is very appropriate as Nachtigall writes not only about insect flight, but gives a glimpse into the ways in which physicists think. Never, however, does he forget that the object of his research is an animal and a very complex one at that.

His opening statement sets the stage for this unusual book, when he asks "a blue bottle irritates us with its buzzing and we squash it. What have we destroyed?" The remainder of the book answers his question.

There are 44 chapters in this book of only 153 pages and consequently some chapters are very short – often less than one page. This large number of short chapters unfortunately at times gives the impression that the book is only a series of loosely connected ideas. However, this does not detract from the book's worth.

Nachtigall, in his forward, states that the book is aimed at the general reader and student. But, although he is meticulously careful in his explanation of the physics involved, once past the initial chapters on general entomology a more than rudimentary knowledge of physics is a decided advantage.

Nachtigall first explains the forces that act on a gliding body, illustrating his discussion with everyday examples, such as gliders and powered flight. Almost without realizing it the reader is then introduced to the way in which these forces act on an insect and its wings.

Explained at length is the difficulty of observing wing beats with frequencies of only a few hundredths of a second. He almost apologizes for spending \$30,000 and many hours of computer time just in studying "a tiny fly", but explains that this amount of money is not large if it serves to add meaningful information to man's reservoir of knowledge.

Chapters 15 and 16 which tell of the ways insect wings generate lift and thrust are superb, and for me are one of the high spots of the book. His explanation of how the wings generate lift and thrust on the upstroke is particularly clear and easily understood (provided the reader understands a parallelogram of forces).

Having considered the forces that keep the insect in the air, Nachtigall next considers the mechanics of power transfer to the wing. He gives an average treatment of the "click mechanism" and then considers the thorax as a resonating system that stores and releases energy.

He has an interesting series of chapters (a single chapter would serve as well), on the way oxygen and fuel are supplied to the flight muscles, making comparisons with everyday objects. He refers to one athletic fly that flew on a flight mill for six days, being regularly "tanked up with a sugar solution". The fly stopped only when its wings were torn and tattered and Nachtigall marvels at the magnificent "motor" that drove the wings up and down some eight million times without breaking down. Another particularly good section of the book are chapters 28 to 31 where he explains how fast and slow flight muscles work, and how the muscle contractions are initiated and maintained. Also well done are the chapters on flight initiation, maintenance and landing. In chapter 34 he explains effectively how one pair of mesothoracic direct flight muscles initiates the downstroke of the wing at take-off. This can be shown by making a fly take off from smoked paper, and observing that the mesothoracic legs leave a larger white mark since they pushed hardest, and thereby giving the dorsolongitudinal flight muscles a strong stimulus for contraction.

The book is lavishly supplied with extraordinarily good photos of insects in flight. There is a particularly good series of photographs of *Bombylius* flies illustrating the stylized flying attitude of this insect.

Nachtigall is not as effective in some chapters covering topics peripheral to insect flight. This shows towards the end of the book where he considers direction finding and wing-beat frequency as a mating stimulus. It is puzzling that earlier in the book in chapter 32 on "Steering gear", he is also rather poor and the chapter does not seem well-placed.

The book is well-produced and bound and contains few mistakes. However, occasionally there appears to have been layout problems, as on page 87 where there is a peculiar hiatus in the double columns.

There are no references given in the text, but the pertinent literature is listed by chapter in a bibliography at the end of the book, along with an adequate index.

This book is essential reading for all entomologists. Not just for the information that it contains on the physics of insect flight, but for the appreciation of Nachtigall's wonder and amazement of how all the many facets of that "small blue-black troublesome buzzing creature" have evolved together to produce a highly efficient animal, a fly.

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